Remedial Investigation Report

Lower Fox River and Green Bay, Wisconsin

Prepared for:

Wisconsin Dept. of Natural Resources

Prepared by: The RETEC Group, Inc.
Natural Resource Technology, Inc.

December 2002

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Lower Fox River and Green Bay, Wisconsin

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NRT Project No.: 1300

Prepared for:

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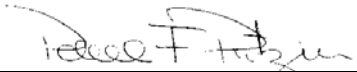

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December 2002

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List of Acronyms

AOC	Areas of Concern
ATSDR	Agency for Toxic Substances and Disease Registry
AVM	acoustical velocity meter
BCF	bioconcentration factor
BBL	Blasland, Bouck, & Lee
BEHP	bis2-ethylhexylphthalate
°C	degrees Celsius
CDF	confined disposal facility
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	cubic feet per second
cm	centimeter(s)
COPC	chemical of potential concern
CWA	Clean Water Act
DDD	p,p'-Dichlorodiphenyldichloroethane
DDE	p.p'-Dichlorodiphenyldichloroethylene
DDT	p.p-Dichlorodiphenyltrichloroethane
DO	dissolved oxygen
ECWRPC	East Central Wisconsin Regional Planning Commission
EIS	Final Environmental Impact Statement
EPA	United States Environmental Protection Agency, Region 5
Exponent	Exponent Environmental Group
°F	degrees Fahrenheit
F&VD	Foth & Van Dyke
FRRAT	Fox River Remediation Advisory Team
FRDB	Fox River Database
FRG	Fox River Group, which is comprised of the following seven companies listed alphabetically: Appleton Papers, Inc., Fort James Corporation; P.H. Glatfelter Company; NCR Corporation; Riverside Paper Corporation; U.S. Paper Mills Corporation; and Wisconsin Tissue Mills, Inc.
FS	Feasibility Study
ft	foot (feet)
ft^2	square feet
ft/s	foot per second
g	gram(s)
g/year	grams per year
GAS	Graef, Anhalt, Schloemer, and Associates, Inc.
GBMBS	Green Bay Mass Balance Study
GBMSD	Green Bay Metropolitan Sewerage District
GBTOXe	Green Bay Toxics Model

List of Acronyms

GIS	Geographic Information System
GLC	Great Lakes Commission
GLNPO	USEPA Great Lakes National Program Office
GLWQA	Great Lakes Water Quality Agreement
gpm	gallons per minute
HDPE	high-density polyethylene
IGLD 1985	International Great Lakes Datum, zero elevation at Rimouski, Quebec, Canada
IJC	International Joint Commission
in	inch(es)
IPS	Integrated Papers Services
kg	kilogram
km	kilometer(s)
km^2	square kilometers
km^3	cubic kilometers
Koc	log water/organic carbon partition coefficient
Kow	log octanol/water partition coefficient
LLBdM	Little Lake Butte des Morts
LTA	long-term average
LUST	leaking underground storage tank
m	meter(s)
m^2	square meters
m/s	meters per second
m^3	cubic meters
m^3/s	cubic meters per second
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MGD	million gallons per day
mi	mile(s)
mi^2	square miles
mi^3	cubic miles
MNFI	Michigan Natural Features Inventory
MSA	Metropolitan Statistical Area
MT	metric tonnes
NWR	national wildlife refuge
NAWQA	USGS National Water Quality Assessment Program
NCP	National Contingency Plan
NCR	National Cash Register
ng/kg	nanograms per kilogram

List of Acronyms

ng/L	nanograms per liter
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
NPL (Superfund)	National Priority List
NRC	National Research Council
NURE	National Uranium Resources Evaluation project
NWR	National Wildlife Refuge
OZ	ounce
PAH	polynuclear aromatic hydrocarbon
PCB	Polychlorinated Biphenyl
PCP	Pentachlorophenol
pg/m^3	picograms per cubic meter
ppb	parts per billion (μg/kg or μg/L)
ppm	parts per million (mg/kg or mg/L)
ppt	part per trillion (ng/kg or ng/L)
Project Team	The Fox River Project Team
PRP	Principal Responsibility Parties
PSC	Public Service Commission
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RA	Risk Assessment
RAP	Remedial Action Plan
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
SAIC	Science Application International Corporation
SAV	submerged aquatic vegetation
SCS	Soil Conservation Service
SEF	Sediment enrichment factor
SLRA	Screening Level Risk Assessment
SMU	Sediment Management Unit
SQG	sediment quality guideline
SRD	Sediment Remediation Demonstration
SVOC	semi-volatile organic compound
SWA	State Wildlife Area
SWE	Snow-Water Equivalent
TCLP	Toxicity Characteristic Leaching Procedure
TOC	total organic carbon
TRI	EPA Toxic Release Inventory database
TSCA	Toxic Substance Control Act

List of Acronyms

TSS	total suspended solids
μg/kg	microgram per kilogram
UP	Michigan's Upper Peninsula
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
UST	underground storage tank
UWSGI	University of Wisconsin Sea Grant Institute
VOC	volatile organic compound
W.A.	Wildlife Area
W.A.C.	Wisconsin Administrative Code
WCC	Woodward-Clyde Consultants (formerly EWI Engineering Associates)
WDNR	Wisconsin Department of Natural Resources
WGNHS	Wisconsin Geological and Natural History Survey
WPDES	Wisconsin Pollution Discharge Elimination System
WPSC	Wisconsin Public Service Corporation
WSCO	Wisconsin State Climatology Office
WTM 27	Wisconsin Trans-Mercator Projection, 1927
WWTP	Wastewater Treatment Plant
WY	Water Year
yd^3	cubic yard
YOY	Young-of-year fish

EXECUTIVE SUMMARY

The Remedial Investigation (RI) report summarizes the physical, chemical, and biological characteristics of the Lower Fox River and Green Bay. The purpose of the RI report is to compile and evaluate these data to support development of the Baseline Human Health and Ecological Risk Assessment (RA) and Feasibility Study (FS). The RA identifies the risks posed to human health and the environment by compounds of concern. The FS develops and evaluates a range of remedial alternatives to support the selection of a remedy that will eliminate, reduce and/or control these risks. This RI/FS report is consistent with the findings of the National Academy of Science's National Research Council Report entitled *A Risk Management Strategy for PCB Contaminated Sediments. (NRC, 2001).*

The RI study area includes the Lower Fox River extending 63 km (39 mi) from Lake Winnebago to Green Bay as well as the entire 4,150 km^2 (1,600 mi^2) of the bay. Green Bay is 190 km (119 mi) in length and averages 37 km (23 mi) in width. The Lower Fox River was subdivided into four river reaches. Green Bay is subdivided into zones 2, 3, and 4 (Figure 1). The Green Bay Area of Concern, as designated by the International Joint Commission, is defined as the De Pere to Green Bay Reach and much of Green Bay Zone 2.

The RI evaluated data from numerous investigations conducted within the study area since 1971, which comprise the Fox River Database (FRDB). Sediment, water, and biological samples in the FRDB include analyses for over 200 chemical parameters. Based on these analyses, a Screening Level Risk Assessment identified polychlorinated biphenyls (PCBs), dieldrin, DDT, dioxins/furans, mercury, lead, and arsenic as the compounds present in the study area that represent potential risks to human health and the environment. However, PCBs are the primary compounds of concern.

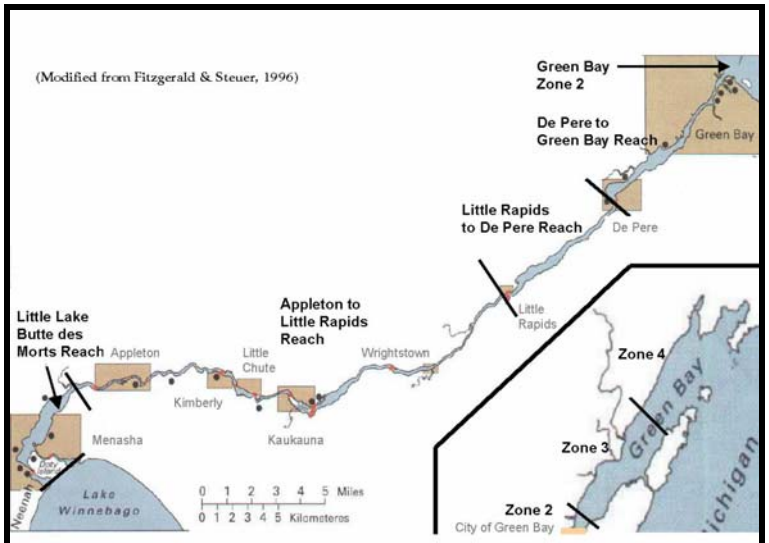

Figure 1. Remedial Investigation Study Areas

Site History and PCB Discharges

In the early 1950s, carbonless copy paper was developed through a process that applied an emulsion containing PCB on paper in a manner that would create document copies. Lower Fox River valley paper mills manufactured and recycled this carbonless paper between 1954 and 1971. About 45 million pounds of PCB were used in the Fox Valley during this time period.

PCBs were released to the environment through manufacturing waste waters and from the de-inking/recycling of waste carbonless copy paper. The Wisconsin Department of Natural Resources (WDNR) estimates the amount of PCB that was discharged to the Lower Fox River from these activities is 313,600 kg (691,370

pounds), with a range from 126,450 kg to 399,450 kg (278,775 to 880,640 pounds). WDNR believes that five facilities contributed over 99 percent of the total PCBs discharged to the Lower Fox River by the end of 1971.

In the late 1970s, commercial production of PCBs in the United States was prohibited due to concerns for human health and the environment. At the present time, some minor unavoidable point source discharges along with atmospheric deposition of PCB continue, but are small compared to the PCB mass present in the river and bay sediments.

Prior to implementation of the federal Clean Water Act in 1972, rough fish were the main species that could live in the Lower Fox River. With implementation of the Clean Water Act and more stringent control over wastewater discharges, water quality in the river improved and game fish began to return to the river. PCBs were detected in trout from Green Bay as early as 1971. Due to continued elevated PCB levels, WDNR issued advisories for public consumption of fish (1976) and waterfowl (1983) derived from Green Bay and the Lower Fox River. The state of Michigan also issued consumption advisories for Green Bay fish in 1977.

PCB Distribution and Sediment Volumes

Considering sediments containing more than 50 μg/kg PCB, about 28,600 kg (63,050 pounds) of PCBs are contained within about 9 million m^3 (11.8 million yd^3) of sediment in the Lower Fox River. In Green Bay, approximately 68,200 kg (150,300 pounds) of PCBs are dispersed in about 465 million m^3 (610 million yd^3) of sediment. The distribution of PCB mass, sediment volume and sediment areal extent are shown on Figure 2. Also shown on Figure 2 is the ratio of PCB mass to sediment volume. The reaches upstream of the De Pere dam are combined on Figure 2 because of their relatively small PCB mass, sediment volume and areal extent.

Much of the PCB discharged into the Lower Fox River has already been transported downstream and is now concentrated in sediments within specific areas:

- The De Pere to Green Bay Reach contains almost 26,000 kg of PCB, which represents about 91 percent of the mass remaining in the river. This reach contains just under 27 percent of the total PCB mass in the system and is concentrated within a relatively small area comprising just over one percent of the total sediment volume. This reach also exhibits the highest mass of PCB per volume of sediment.

- Approximately 70 percent of the total PCB mass in the system has migrated from the river into Green Bay.

- The PCB mass in Green Bay is dispersed over an extraordinarily large area and in an extremely large sediment volume. Almost half of the total PCB mass in Green Bay is found in Zone 2.

Sediment and PCB Transport

Particle size and cohesion along with river/bay conditions, especially current speeds, control the deposition, resuspension, and transportation of sediments (and the PCBs absorbed to them). In the Lower Fox River, sediments have accumulated in 35 separate deposits above

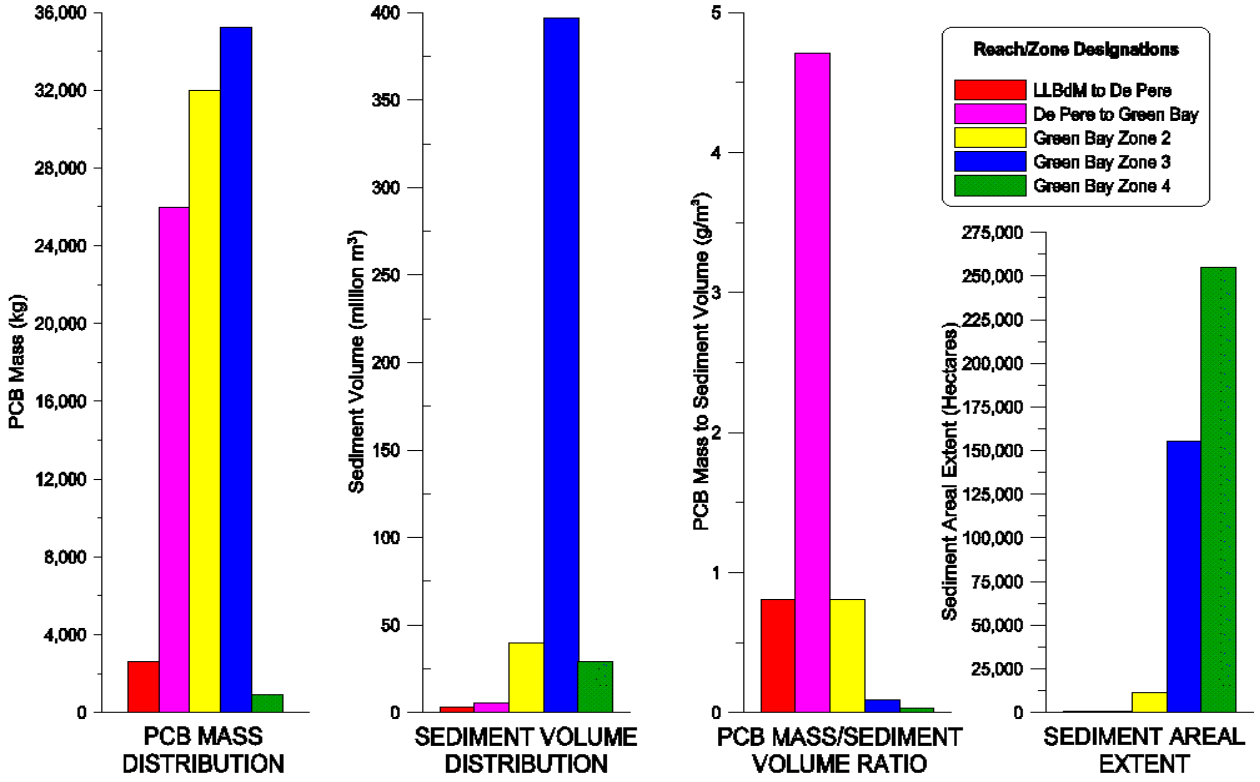

Figure 2. PCB Mass & Sediment Volume/Area Distribution by river reach and bay zone

the De Pere dam. Below the De Pere dam and in Green Bay, where current speeds tend to be lower, sediments cover large areas of the river and bay bottom, except in areas where the sediments are dredged to maintain ship navigation. The highest PCB concentrations have also been observed in the LLBdM and De Pere to Green Bay reaches, in the vicinity of historic discharge points.

The average river discharge was about 122 m^3/s (4,300 cfs) between 1989 and 1998. Due to storm events and spring snowmelt, the river discharge exceeds 272 m^3/s (9,600 cfs) more than 10 percent of the time. These faster currents have the capability to resuspend and transport larger particle sizes and greater volumes of sediment and, therefore, a greater mass of PCB. Field measurements and computer modeling results suggest that these less-frequent, high-discharge events transport much of the PCB mass in the river over the De Pere dam and into Green Bay. In addition to sediment transport, PCB migrates due to dissolution in water and adsorption onto algae and other organic matter. The PCB mass transported from reach to reach increases along the river. Based on sampling data collected as part of the Green Bay Mass Balance study in 1989-90, about 280 kg (610 pounds) of PCB were transported to Green Bay during the study period. Based on work done in 1994-95 as part of the Lake Michigan Mass Balance, it was estimated that 220 kg (485 pounds) of PCB moved from the river into the bay. PCB loads to the bay vary as the river flow varies. This mass represents up to 1 percent of the PCB mass in the river.

Sediment discharged from the Lower Fox River is directed toward the east shore of Green Bay by counterclockwise currents. This sediment-rich water can extend between 20 km to 40 km (12 mi to 24 mi) along the east shore. Fluctuating water levels, wave action and reverses in stream flow in this area facilitate sediment transport and mixing. Consequently, large volumes of sediment containing PCB are present along the southern and eastern portions of Green Bay. At least 68,200 kg (150,300 pounds) of PCBs already reside in the bay. Over 95 percent of the PCB that occurs in Green Bay is derived from the Lower Fox River.

This transport of PCB also extends into Lake Michigan. During 1989/90, it was estimated as part of the Green Bay Mass Balance Study that about 122 kg (270 pounds) of PCBs were transported from Green Bay to Lake Michigan. Other mass transport pathways (such as volatilization) also exist.

Ecological Samples and Characteristics

Exposure of biota to sediments and water containing PCB fosters uptake of PCBs into the food chain. Wetlands, submerged aquatic vegetation, and islands along the Lower Fox River and Green Bay offer nesting/spawning, feeding, and refuge opportunities for fish, birds, and animals. Other lacustrine, riverine, and estuary features also provide habitat for regional wildlife. In addition to birds and fish, the FRDB contains information on PCBs in deer, otter, mink, and various insects and invertebrates. The RA evaluates PCB uptake and accumulation in selected species and the associated human health and environmental risks. Areas with higher PCB concentrations tend to pose a greater risk of exposure.

Effects of Time

The FRDB includes sediment and water results from over a 10 year period while tissue samples were collected between 1971 and 1999. During the 1970s, after PCB discharges into the river ceased, PCB concentrations in fish tissue showed significantly declining concentrations. However, since the mid-1980s, changes in the rate of PCB decline in fish tissue have been observed. Changes in PCB levels in fish tissue have either slowed, remained constant, or is some cases actually increased.

PCB concentration trends in the upper 10 cm (4 in) of sediment are inconsistent, but generally appear to be decreasing over time as more PCB is transported downstream. Soil eroded from the watershed mixes with and may further dilute PCB concentrations in the sediments.

Further Information

The selection of remedies for the Lower Fox River and Green Bay will consider the information within the RI, RA and FS, as well as input by the public and interested parties. For further information, please contact:

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